ASOS MAINTENANCE NOTE 54, (for Electronics Technicians)
Maintenance, Logistics, and Acquisition Division
W/OPS12: AL

DTS1 Dewpoint Sensor Documentation

GENERAL

Update to the Automated Surface Observing System (ASOS) Site Technical Manual (STM) (S100), to include Chapter 17 for the DTS1 Dewpoint Sensor.

PROCEDURE

Insert and maintain Chapter 17, DTS1 Dewpoint Sensor in the ASOS STM (S100), Revision A, Change 2. All subsequent versions of the STM shall include this chapter.

EFFECT ON OTHER INSTRUCTIONS

This maintenance note affects ASOS STM, Revison A, Change 2, August 2000. The DTS1, Dewpoint Sensor chapter number will be reassigned in future revisions to the STM.

REPORT MAINTENANCE ACTION

None.

? Signature Not Verified

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CHAPTER 17

DTS1 DEWPOINT SENSOR

SECTION I. DESCRIPTION

17.1.1 INTRODUCTION

This chapter provides field service information for the DTS1 Dewpoint Sensor. The information in this chapter includes physical description, operation, theory of operation, and preventive and corrective maintenance.

A mounting frame attaches the DTS1 sensor to the same three-inch pole upon which the 1088/H083 temperature/dewpoint sensors are mounted. The orientation of the DTS1 mounting frame is north, in line with the centerline of the 1088/H083 and to the left of the enclosure door, so that the sensor arm of the DTS1 extends in the direction opposite that of the 1088/H083 aspirated radiation shield ("mushroom").

17.1.2 PHYSICAL DESCRIPTION

Refer to Figures 17.1.3-1 and 17.1.3-2 for DTS1 Field Replaceable Units (FRU) component identification.

17.1.2.1 Electronics Enclosure (2MT4-3A1)

The NEMA 4X electronics enclosure is made of grade 304 stainless steel and has a white paint finish. It is 9.4 inches wide, 14.2 inches high, and 5.9 inches deep. Internal components are mounted on a plate which is affixed to the back wall of the enclosure. All components, except the heaters, are attached to a mounting rail for fast replacement.

The enclosure includes the DTT1 dewpoint transmitter with integral probe assembly, fiber optic module, power supply, heating relay, cut-off thermostat, heaters, terminal blocks (including fuses), and a mechanical power switch for electrical power to both the sensor and the enclosure heaters.

At the bottom of the enclosure is a water tight cable bushing for the sensor probe cable. The enclosure has a door stop to keep the door open when it is windy and a radiation shield for protection against solar radiation. An internal grounding wire between the body and the enclosure door keeps the door grounded when open. Power wires and fiber optic cables enter through the bottom of the enclosure.

The bottom of the enclosure also has a pressure compensation element which breathes to avoid pressure difference caused by rapid changes in temperature as well as avoid (or at least minimize) dew formation inside the enclosure.

17.1.2.2 Dewpoint Transmitter/Probe (2MT4-3A1A1)

The DTT1 transmitter/probe assembly measures relative humidity (RH) and temperature and calculates dewpoint. It has extensive self-diagnostics and measures its own internal temperature to control the internal heating of the electronics enclosure. A fiber optic module transfers data to the ASOS Data Collection Package (DCP) or Acquisition Control Unit (ACU).

17.1.2.3 Fiber Optic Module (Alternate ASN 2MT4-3A1A3)

The fiber optic module is the standard ASOS module used in other sensors (ASN S100-2A3A1-1).

17.1.2.4 Power Supply (2MT4-3A1PS1)

The power supply operates on 115 VAC (± 10%) single phase power and outputs 24 VDC for the dewpoint temperature transmitter. A 220-ohm load resistor is connected to the output of the power supply to ensure startup of the power supply in extremely cold conditions.

17.1.2.5 Heaters (2MT4-3A1HR1)

The enclosure is heated by two PTC (positive temperature coefficient) heating elements. The power per heater is 26 to 37 Watts over the ambient temperature range of -76°F to 32°F. Heating power decreases as the ambient temperature increases. Heating power is turned on when the enclosure's internal temperature drops below 32°F or when the temperature drops below the rated operating range of the sensor's electronics. The heater is turned off when the temperature rises above 50°F. In case of malfunction, a cut-off thermostat turns the heater off when the temperature reaches 140°F.

The heaters are attached to the back plate for effective heat transfer. A transparent protection shield provides personal protection from the hot heater elements.

17.1.2.6 Solar Shield (2MT4-3A2MP2)

The probe/sensor head, capped by a manually replaceable filter, is mounted in the solar shield. The open structure of the shield ensures steady air circulation to the sensor head under all weather conditions.

17.1.3 SENSOR CONFIGURATIONS

A single type (design) sensor supports all ASOS configurations.

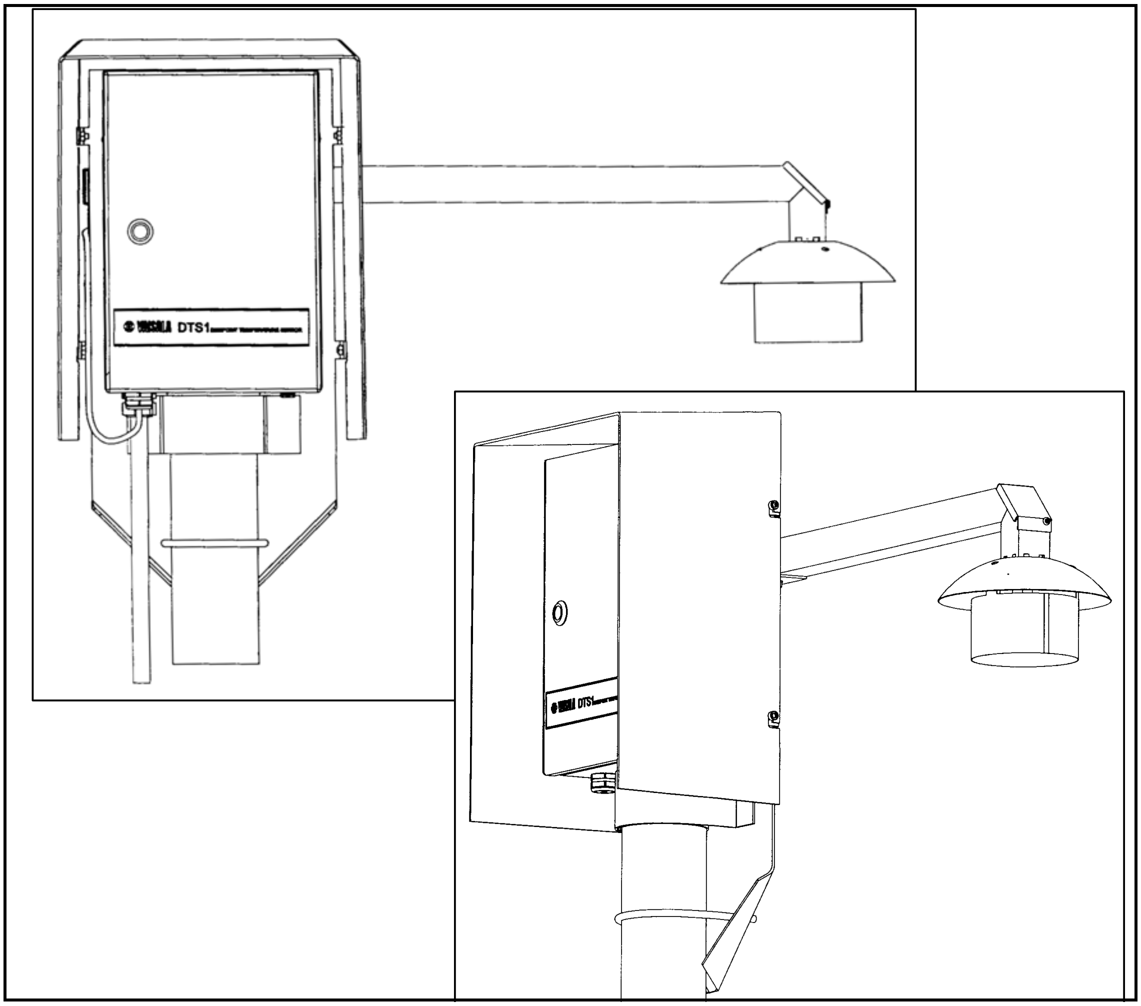

Figure 17.1.3-1 DTS1 Dewpoint Sensor

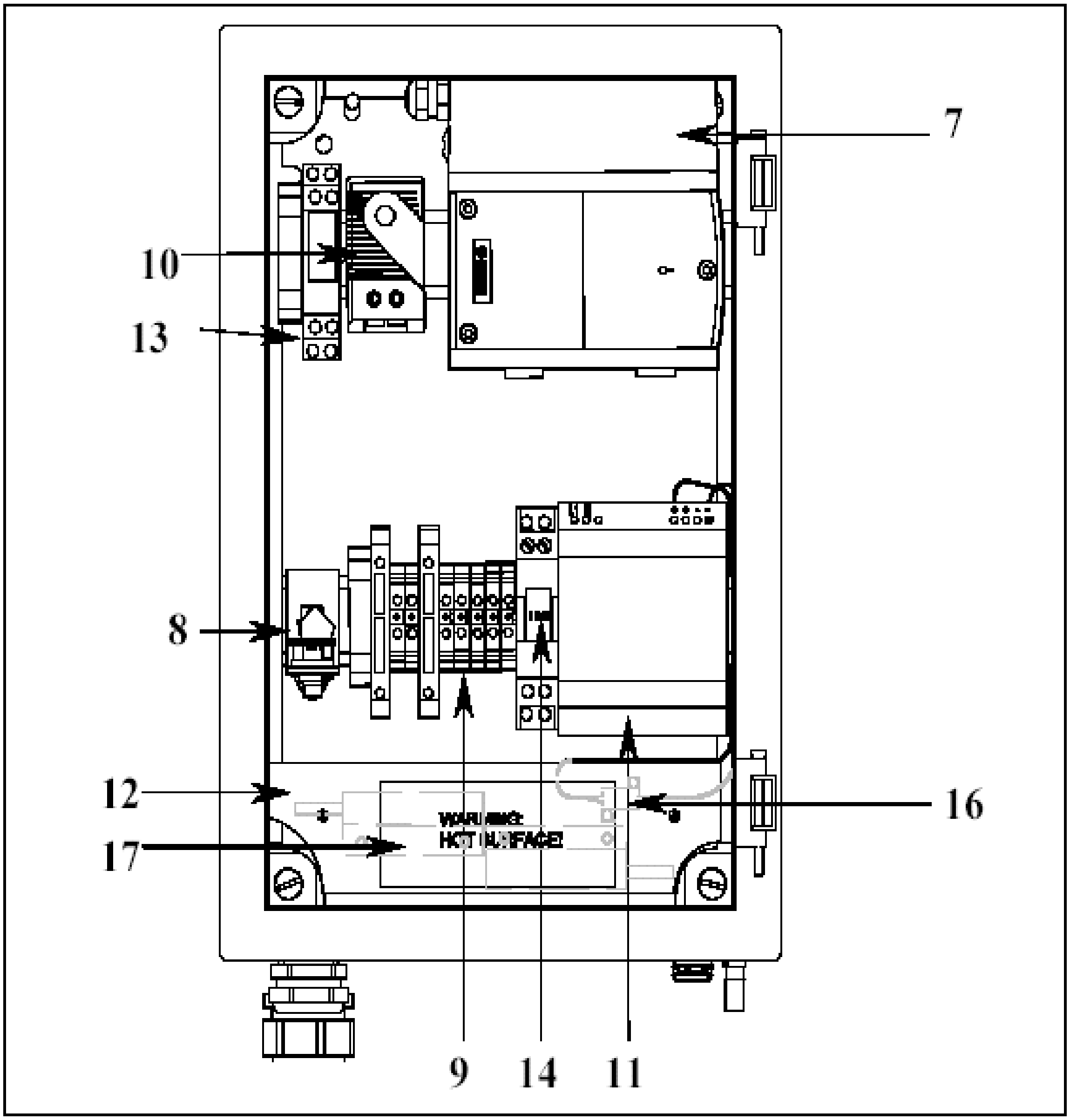

Figure 17.1.3-2 DTS 1 Components

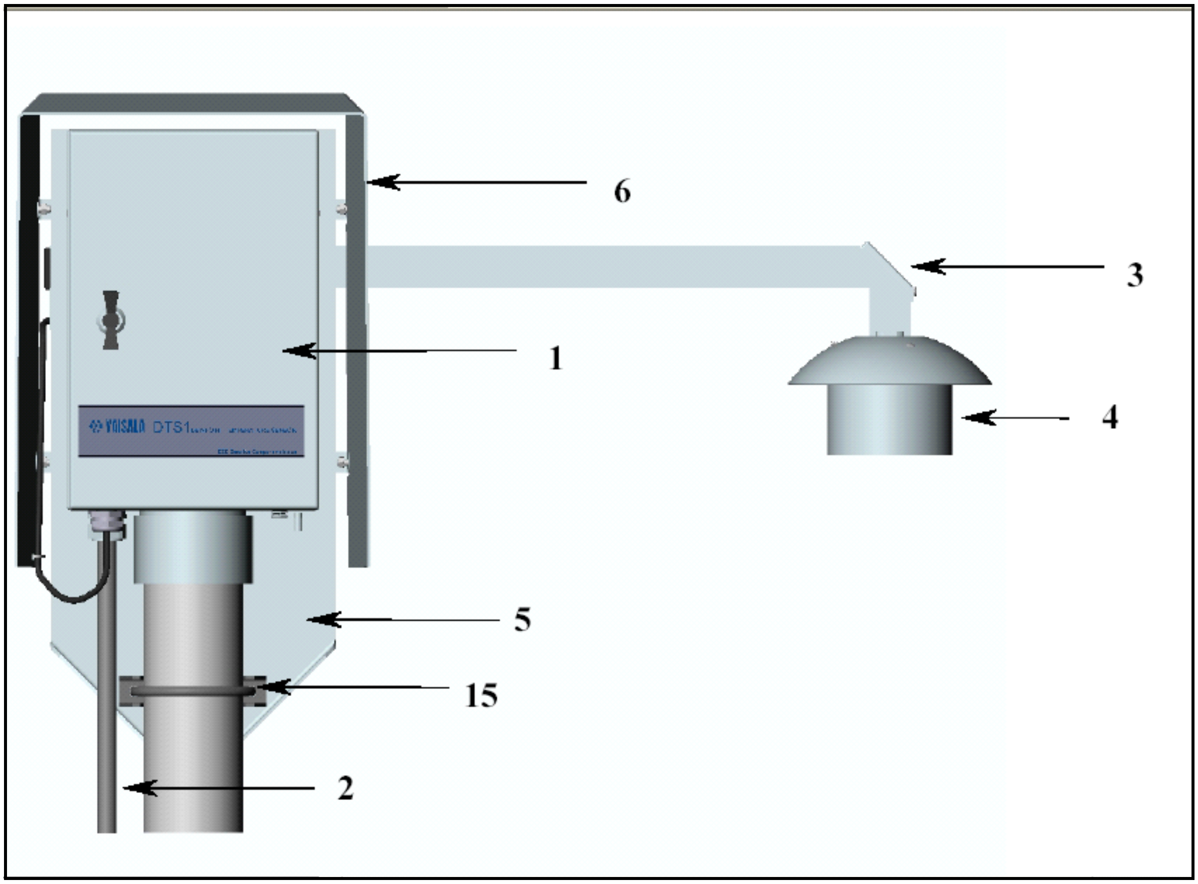

Figure 17.1.3-3 DTS 1 Components

Table 17.1.3-1 DTS Components

1. Enclosure	10. Overtemperature protection thermostat
2. Liquid light conduit (for fiber optic cables & power supply wires)	11. Power supply
3. Crossbar	12. Heaters protective plate
4. Solar Shield of the probe	13. Relay to control the heaters
5. Mounting shield	14. ON/OFF switch
6. Radiation shield	15. Supporting bracket
7. DTT1 dewpoint temperature transmitter	16. Loading resistor
8. Fiber Optic Modem	17. Enclosure heater (behind the protective plates
9. Screw Terminals	

Table 17.1.3-2 Field Replaceable Units

6. Radiation shield	11. Power supply unit
7. DTT1 Dewpoint Temperature Transmitter	13. Heating Relay
8. Fiber Optic modem	16. Loading resistor
10. Overtemperature protection thermostat	17. Enclosure Heater

SECTION II.

(This section reserved for future use.)

SECTION III. OPERATION

17.3.1 INTRODUCTION

The DTS1 Dewpoint Sensor is an unattended device operating continuously under the control of the DCP and/or ACU. The dewpoint temperature readings are displayed in the 12-hour data page. This page is shown and explained in Chapter 1.

17.3.2 SENSOR POWER

Sensor power is applied by opening the enclosure door and turning the power switch ON. The sensor is designed for continuous operation and should be turned off only for maintenance. When necessary, turn the sensor off by opening the enclosure door and turning the power switch OFF.

17.3.3 SERIAL INTERFACE SETTINGS

The sensor communicates via RS232 serial interface with the ASOS (sensor is polled every 10 seconds) and a laptop computer connected to the J3 Service port. The data format is:

1. 1 start bit
2. 8 data bits
3. 1 stop bit
4. No parity
5. 2400 bits per second, programmable to 9600 bps
6. Full duplex
7. Serial asynchronous

17.3.4 INTERROGATION COMMANDS

ASOS system software routinely polls the DTS1 with interrogation requests to determine sensor status for display on the 1-minute and maintenance screens.

The following commands are also available for issuance from the J3 Service port:

1. D1 - Send dewpoint temperature and status data
2. DD - Perform extended diagnostics
3. DF - Send fixed data
4. DT - Execute built-in test
5. DR - Sensor Initialization
6. DH - Display sensor command help

These requests can also be initiated when the serial interface is in full duplex mode. Commands are not case-sensitive (capital and small letters are both acceptable) and are executed by typing the desired command followed by <ENTER>. Results are displayed as either P (pass) or F (fail).

17.3.4.1 Dewpoint Temperature (D1 Command)

Type D1 commands output ten seconds average dewpoint temperature data in degrees Fahrenheit and sensor status. Responses to the D1 command and example output are listed in Table 17.3.4.1-1.

Table 17.3.4.1-1 D1 Command Output

Byte	Description	Value
1	Start of transmission	STX
2	Sensor ID	D
3	Message ID	1
4	Sensor status	P or F
5	Dewpoint temperature sign	+ or -
6-9[a]	Dewpoint temperature in degrees F	XX.X
10	ASCII space character	" "
11-12[b]	Checksum	XX
13	End of transmission	ETX
14	Carriage return	CR
15	Line feed	LF
Example Output		
D1F+63.8 D5		

a. Bytes 6-9 represent the ASCII encoded dewpoint temperature in fixed decimal format. Leading zeros are transmitted as ASCII space characters (20 Hex).

b. Bytes 11-12 form a two-byte field containing an ASCII encoded hex value which is a modulus 256 checksum for the data in bytes 2-10. Byte 11 represents the most significant four bits of the checksum; byte 12 represents the least significant four bits.

17.3.4.2 Extended Diagnostics (DD Command)

Type DD to execute the extended built-in diagnostics and display the temperature of the enclosure in degrees Fahrenheit. Responses to the DD command and example output are listed in Table 17.3.4.2-1.

Table 17.3.4.2-1 DD Command Output

Byte	Description	Value
1	Start of transmission	STX
2	Sensor ID	D
3	Message ID	D
4	Sensor status	P or F
5	Dewpoint transmitter status	P or F
6[a]	Transmitter operating voltage status	P or F
7	Enclosure heating	P or F
8[b]	Enclosure temperature	P or F
9	Enclosure temperature sign	+ or -
10-14[c]	Enclosure temperature in degrees F	XXX.X
15	ASCII space character	" "
16-19[d]	Operating voltage	XX.X
20	ASCII space character	" "
21-23[e]	Heater status	ON or OFF
24	ASCII space character	" "
25-26[f]	Checksum	XX
27	End of transmission	ETX
28	Carriage return	CR
29	Line feed	LF
Example Output		
DDFFFPP+ 41.6 11.0 OFF 09		

a. If output is F, see Paragraph 17.5.3.3.2.
b. Byte 8 shows F status if the enclosure temperature is below -40° F.
c. Bytes 10-14 represent the ASCII encoded enclosure temperature in fixed decimal format. Leading zeros are transmitted as ASCII space characters (20 Hex).
d. Bytes 16-19 represent the ASCII encoded operating voltage in fixed decimal format. Leading zeros are transmitted as ASCII space characters (20 Hex).
e. Bytes 21-23 represent the heater status (ON or OFF). An ON message includes a leading ASCII space character (20 Hex).
f. Bytes 25-26 form a two-byte field containing an ASCII encoded hex value which is a modulus 256 checksum for the data in bytes 2-24. Byte 25 represents the most significant bits of the checksum; byte 26 represents the least significant four bits.

17.3.4.3 Verify the Communications Link (DF Command)

Use the DF command to verify the communications link. Response to the DF command and example output are listed in Table 17.3.4.3-1.

Table 17.3.4.3-1 DF Command Output

Byte	Description	Value
1	Start of transmission	STX
2	Sensor ID	D
3	Message ID	F
4	Sensor status	P or F
5-9	Fixed temperature value	+98.7
10	ASCII space character	" "
11-12[a]	Checksum	XX
13	End of transmission	ETX
14	Carriage return	CR
15	Line feed	LF
Example Output		
DFF+98.7 F1		

a. Bytes 11-12 form a two-byte field containing an ASCII encoded hex value which is a modulus 256 checksum for the data in bytes 2-10. Byte 11 represents the most significant four bits of the checksum; byte 12 represents the least significant four bits.

17.3.4.4 Built-in Test (DT Command)

The DT command executes the sensor's built-in test. Response to the DT command and example output are listed in Table 17.3.4.4-1.

Table 17.3.4.4-1 DT Command Output

Byte	Description	Value
1	Start of transmission	STX
2	Sensor ID	D
3	Message ID	T
4	Sensor status	P or F
5	ASCII space character	" "
6-14[a]	Firmware version	
15	ASCII space character	" "
16-17[b]	Checksum	XX
18	End of transmission	ETX
19	Carriage return	CR
20	Line feed	LF
Example Output		
DTF DTT1/1.01 2A		

a. Bytes 6-14 represent the firmware version. Example output: DTT1/1.00.

b. Bytes 16-17 form a two-byte field containing an ASCII encoded hex value which is a modulus 256 checksum for the data in bytes 2-10. Byte 16 represents the most significant four bits of the checksum; byte 12 represents the least significant four bits.

17.3.4.5 Sensor Initialization (DR Command)

The DR command is automatically executed at system power-up. It can also be initiated from a laptop when initialization is required. Response to the DR command and example output are shown in Table 17.3.4.5-1.

Table 17.3.4.5-1 DR Command Output

	Parameter	**Description**
Line 1		Sensor name
Line 2	Sensor:	Sensor revision in format yyyy-mm-dd
Line 3	Firmware:	Firmware version
Line 4	Serial:	Vaisala serial number
Line 5	Calibration:	Previous calibration date in format yyyy-mm-dd
Line 6	Sensor status:	Sensor status, either PASS or FAIL
Example Output		
DTS1		
Sensor	: A2001-09-10	
Firmware	: DTT1/1.01	
Serial	: V3120021	
Calibration	: 2001-03-09	
Sensor status	: PASS	

17.3.4.6 Help (DH Command)

Use the DH command (without parameters) to display a list of the maintenance commands defined in Paragraph 17.3.5. Command parameters (i.e., maintenance command designation) can be used to generate the maintenance command's output. Examples of DH commands by category and example output are listed in Table 17.3.4.6-1.

Table 17.3.4.6-1 DH Commands

BASIC OPERATION:	?, ERRS, FTIME, HELP, INTV, R, RESET, S, SEND, STAT, TIME, and VERS
CALIBRATION:	C, CDATE, CI, CTEXT, FL, L, TACAL, TCAL, and TELCAL
CONFIGURATION:	BNUM, RTEXT, SERIO, SNUM, and STEXT
TESTING:	TEST and TESTEH
Example Output (to DH ERRS<ENTER>)	
Name:ERRS Use:ERRS [0...16] Info:Print error messages	

17.3.5 MAINTENANCE COMMANDS

All maintenance commands are executed from a laptop connected to the J3 Service port by typing the command (and appropriate command line parameters) followed by <ENTER>.

17.3.5.1 Sensor Malfunction (ERRS Command)

The ERRS command is used alone and/or with parameters 0 through 16 to output extended diagnostics information. When used alone, the response is either PASS or FAIL with a description of the failure, such as:

FAIL
Error: Enclosure heating malfunction
Error: Probe heating error
Use command line parameters to access the error log stored in non-volatile memory. The command "ERRS 0" will display a table of all errors in memory and then these errors can be accessed in more detail with a parameter from 1 to 16, with error number one as the most recent error. The following is an example of an error log displayed in response to the command "ERRS 0":
Error log:
1: 00:00:01.90 Code : [0000 00C0]
2: 00:00:01.90 Code : [0000 00C0]
3: 00:00:01.90 Code : [0000 00C0]
4: 00:00:01.90 Code : [0000 00C0]
5: 00:00:56.11 Code : [0000 00C0]
6: 00:00:48.46 Code : [0000 00C8]
7: 00:00:47.17 Code : [0000 0008]
8: 00:00:01.90 Code : [0000 0088]
9: 00:00:16.14 Code : [0000 0088]
10: 00:00:19.76 Code : [0000 008A]
11: 00:00:01.90 Code : [0000 008E]
12: 00:00:01.90 Code : [0000 0088]
13: 00:00:27.68 Code : [0000 0088]
14: 00:00:20.03 Code : [0000 008A]
15: 00:00:01.90 Code : [0000 008E]
16: 00:00:01:68 Code : [0000 0008]

The following is an example of a response to the command to review error number two in more detail (command "ERRS 2"):
Error #2:

Time	:	00:00:01.90
Temperature	:	35.81 ‘C
Relative humid	:	66.54 %RH
Dewpoint temp	:	83.48 ‘F
Resistance	:	113.923 ohm
Capacitance	:	207.449 pF
Electronic temp	:	3.25 ‘C
Operating volt	:	11.10 V
Analog volt	:	3.91 V

```
Time               :    00:00:01.90
Reference volt     :    2.48 V
Modem volt         :    6.74 V
Tel  enc. test     :    0.00 'C
Probe heat         :    ON
Probe heat pwm     :    3/255
Probe heat test    :    OFF
Enclosure heat     :    OFF
Eh. test manual    :    OFF
Eh. test auto      :     OFF
Calibration        :    OFF
Ch[Ref 1]          :    205.180 mV
Ch[Ref 2]          :    93.575 mV
Ch[T]              :    129.771 mV
Ch[Ta]             :    7500.000 mV
Ch[D1]             :    398.487 mV
Ch[D2]             :    539.400 mV
Ch[ ]              :    7500.000 mV
Ch[0V]             :    0.029 mV
FAIL
Error: Operating voltage out of range
Error: Optical module supply voltage out of range
```

NOTE

Stored information can be used to resolve hardware that are no longer present but have been detected earlier.

NOTE

The error log contains only the 16 most recent errors. A full error log will not be updated; it must be cleared before new errors are accepted.

Use command "INIE ELOG" to clear the error log after the cause of the error has been corrected.

17.3.5.2 Time (FTIME Command)

Use the FTIME ON and FTIME OFF commands to enable or disable a time stamp in the output of SEND or R commands. When used without an ON or OFF parameter, FTIME outputs the current setting.

Examples:

```
>SEND<ENTER>
 RH=    65.46 %RH T=    76.55 'F Td=    64.12 'F
>FTIME ON<ENTER>
 FTIME          : ON
```

```
>SEND
 02:58:55.33 RH=    65.45 %RH T=    76.53 ‘F Td=    64.12 ‘F
```

17.3.5.3 Help (HELP Command)

Use the HELP command to display a list of all maintenance commands available for the sensor. See Paragraph 17.3.4.6 for example of an output generated by the HELP command.

17.3.5.4 Clear Error Messages (INIE ELOG Command)

The INIE ELOG command reinitializes the error log by clearing any error messages stored in non-volatile memory. Use this command after the error generating the log entry has been corrected.

17.3.5.5 Set Output Interval (INTV Command)

Set the sensor's interval for continuous output by using the INTV command with a number value and a time parameter (s = seconds, min = minutes, h = hours).

Examples:

```
INTV 1<ENTER>
Output interval:  1 S
INTV 1 min<ENTER>
Output interval:  1 MIN
INTV 20 s<ENTER>
Output interval:  20 S
```

17.3.5.6 Continuous Data Output (R Command)

The R command can be used without parameters to output continuous measured data according to pre-selected intervals (see the INTV command in Paragraph 17.3.5.5). Continuous output is stopped with an S command.

Example:

```
>R<ENTER>
 RH=    65.45 %RH T=    76.53 ‘F Td=    64.12 ‘F
 RH=    65.46 %RH T=    76.53 ‘F Td=    64.12 ‘F
 RH=    65.47 %RH T=    76.53 ‘F Td=    64.12 ‘F
 RH=    65.48 %RH T=    76.53 ‘F Td=    64.12 ‘F
>S<ENTER>
```

17.3.5.6.1 Continuous Data Output Parameter - A

The A parameter outputs A/D converter values (in hexadecimal format) for 8 different channels. The output format is:

```
CH0(ADC) CH1(ADC) CH2(ADC) CH3(ADC) CH4(ADC) CH5(ADC)
CH6(ADC) CH7(ADC)
```

CHn   Channel n A/D conversion data in hexadecimal format

Example output:

```
>R A<ENTER>
```

2EAF12F9 00000000 2F32EA25 2F66510F 2D736ED5 00000000
2FFFF700 2C8C20D6

17.3.5.6.2 Continuous Data Output Parameter - U

The U parameter outputs A/D converter voltages (in millivolts) for 8 different channels. The output format is:

CH0(mV) CH1(mV) CH2(mV) CH3(mV) CH4(mV) CH5(mV)
CH6(mV) CH7(mV)

CHn Channel n A/D conversion data in millivolts

Example output:

>R U<ENTER>
205.692 7500.000 125.199 93.820 398.397 7500.000
0.017 539.482

17.3.5.6.3 Continuous Data Output Parameter - X

The X parameter outputs the measured resistance (in ohms) and capacitance (in picofarads) for the probe and cable assembly. The output format is:

R(ohms) C(pF)

R Resistance

C Capacitance

Example output:

>R X<ENTER>
109.600 207.431

17.3.5.6.4 Continuous Data Output Parameter - S

The S parameter outputs internal self-test values. The output format is:

Vin(V) Va(V) Vref(V) Tel(°C) Vopt(V)

Vin Transmitter supply voltage

Va Internal analogue voltage

Vref Internal reference voltage

Tel Temperature of the electronics

Vopt Supply voltage of the fiber optic modem

Example output:

>R S<ENTER>
11.07 3.91 2.48 5.39 7.08

17.3.5.6.5 Continuous Data Output Parameter - Q

The Q parameter outputs the calculated values from probe measurements. The output format is:

T(°C) RH(%RH) Td(°C)

T Temperature in degrees Celsius

RH Percent relative humidity

Td Dewpoint temperature in degrees Celsius

Example output:

```
>R Q<ENTER>
 24.6589  65.4517  17.7526
```

17.3.5.6.6 Continuous Data Output Parameter - D

The D parameter outputs debug values for 7 different variables. The output format is:

T(°C) RH(%RH) Td(°C) Cm(pF) Cp
dCp 1/pws

T Temperature in degrees Celsius

RH Percent relative humidity

Td Dewpoint temperature in degrees Celsius

Cm Capacitance in picofarads

Cp Scaled capacitance

dCp Pressure compensation

1/pws mathematical computation of 1 over the partial water vapor pressure

Example output:

```
>R D<ENTER>
 24.6664  65.4478  17.7566 207.431  0.66681
 0.00000  0.03219
```

17.3.5.6.7 Continuous Data Output Parameter - T

The T parameter outputs values recorded for temperature compensation calculations. The output format is:

T(°C) RH(%RH) Cm(pF) R(ohms) Tel(°C)

T Temperature in degrees Celsius

RH Percent relative humidity

Cm Capacitance in picofarads

R Resistance in ohms

Tel Electronics temperature

Example output:

```
>R T<ENTER>
 24.6685  65.4486  207.431  109.609  5.39
```

17.3.5.6.8 Continuous Data Output Parameter - H

The H parameter outputs the values for temperature channels 1 and 2. The output format is:

```
H1(mV)   H2(mV)
```

H1 Channel 1

H2 Channel 2

Example output:

```
>R H<ENTER>
 0.1252   7.5000
```

17.3.5.6.9 Continuous Data Output Parameter - DTT

The DTT parameter outputs a list of debugging values for the DTT1 Transmitter. The output format is:

```
Td(°F)   P/F(DTS,DTT,Vin,Eheat,Tel)  Tel(°F)
Vin      Eheat      T(°C)        RH(%RH)    Va
Vref     Vopt       EHTest       Pheat
```

Td Dewpoint temperature in degrees Fahrenheit

P/F Pass/Fail fields for sensor, transmitter, operating voltage, enclosure heating, enclosure temperature

Tel Temperature of the electronics in degrees Fahrenheit

Vin Transmitter supply voltage

Eheat Enclosure heat status, ON/OFF

T Temperature in degree Celsius

RH Relative humidity

Va Internal analogue voltage

Vref Internal reference voltage

Vopt Supply voltage of the fiber optic modem

EHTest Enclosure heating status, always displays time in hours until the next test sequence. In addition, it displays

N for normal operation and minutes since last heating status change,
or
T for test in progress and the minutes since beginning of the test sequence.

Pheat Probe heating power in the PWM/255

Example output:

```
>R DTT<ENTER>
 +64.0 FFFPP+ 41.7 11.1 OFF   24.69   65.45
 3.9  2.5  7.1 N18/153 (3/255)
```

17.3.5.7 Initializing Routine (RESET Command)

Use the RESET command to execute the initialize routine and display the initialization message. See Paragraph 17.3.4.5 for a description of the output.

17.3.5.8 Output Readings (SEND Command)

The SEND command can be used with or without parameters to output measured data. The SEND command without parameters produces a single reading similar to the following:

RH= 65.45 %RH T= 76.53 ‘F Td= 64.12 ‘F
The SEND command with parameters A, U, X, S, Q, T, H, and DTT can also be used to output the last measured data in different formats. See Paragraph 17.3.5.6 for a description of output values.

17.3.5.9 Output Sensor Information (STAT Command)

The STAT command generates sensor information including the sensor initialization message (as specified in Paragraph 17.3.4.5) as well as serial communication settings for the fiber optic module line (SERI0 command), transmitter address (normally unused), and output interval (INTV command).

Example output:

DTS1

Sensor	: A2001 - 09 - 10
Firmware	: DTT1 / 1.01
Serial	: V3120021
Calibration	:2001 - 03 - 09
Sensor status	: FAIL
SCI0 Baud P D S	: 2400 N 8 1
Address	: 0
Output mode	: STOP
Output interval	: 2 S

17.3.5.10 Set Time (TIME Command)

To display the current transmitter software clock time, use the TIME command without parameters. Note in the following example that the time is shown to the 1/100 second.

Example:

TIME<ENTER>
14:20:45.01

Set/change the time by entering TIME followed by the hour, minute, and second.

Example:

TIME 14 21 47<ENTER>
14:21:47.01

NOTE

Time will be set to 00:00:00.00 at sensor reset.

NOTE

Only about 1% accuracy is obtained with the transmitter software clock

17.3.5.11 Output Firmware Version (VERS Command)

Use the VERS command to display the sensor's current software version.

Example:

VERS<ENTER>
DTT1/1.01

17.3.6 TESTING

Test commands entered at the laptop can be used to output intermediate results and self-diagnostics information and force the enclosure heating to a desired state for testing purposes. Test commands and their use are explained in the following paragraphs.

17.3.6.1 Intermediate Results and Self-Diagnostics

Type TEST to start output of intermediate results from measurements as well as self-diagnostics information, such as the supply voltage to the fiber optic module, in real time. Command output is continuous with an interval of approximately one second and can be stopped with command ‘S’. Output consists of the following fields:

CH0 (ADC) CH1 (ADC) CH2 (ADC) CH3 (ADC) CH4 (ADC) CH5 (ADC)

CH6 (ADC) CH7 (ADC)

CH0 (mV) CH1 (mV) CH2 (mV) CH3 (mV) CH4 (mV) CH5 (mV)

CH6 (mV) CH7 (mV)

R ( ) C (pF)

T (°C) RH (%RH) Td (°C)

Vin (V) Va (V) Vref (V) Tel (°C) Vopt (V)

CHn	Multiplexer channel n
R	Measured resistance of the PT100
C	Measured capacitance of the Humicap
RH	Relative humidity
T	Temperature
Td	Dewpoint temperature
Vin	Transmitter supply voltage
Va	Internal analog voltage
Vref	Internal reference voltage
Tel	Temperature of the electronics

Vopt Supply voltage of the fiber optic module

Example output:

2EA333A3 00000000 2F6DF841 2F611DE3 2D5DBFEB 00000000

30000358 2C878225

212.890 7500.000 89.130 96.975 411.530 7500.000

-0.008 542.317

75.139 208.347

-62.9611 86.4039 -64.0537

21.95 3.96 2.49 1.52 4.97

NOTE

Test output is stopped at sensor reset.

17.3.6.2 Setting Enclosure Heating

Type TESTEH with ‘ON', ‘OFF', or ‘AUTO' to force the enclosure heating to a desired state. State AUTO is the normal operating state during which the sensor will automatically control the heating.

Wait at least 30 seconds after power on before using this command. TESTEH ON turns the enclosure on at once, but it takes about 15 seconds after the TESTEH OFF command before the enclosure heating goes to an off state.

Example output:

TESTEH OFF<ENTER>
Enclosure heat OFF
TESTEH ON<ENTER>
Enclosure heat ON
TESTEH AUTO<ENTER>
Enclosure heat AUTO

NOTE

Enclosure heating is returned to automatic operation (AUTO) at sensor reset.

17.3.7 TRANSMITTER REPROGRAMMING

When directed by National Weather Service Headquarters, new sensor firmware versions can be programmed into the DTT1 transmitter's memory via the serial line by using a reprogramming device. The microprocessor has a flash memory to store the firmware. A reprogramming device, cable, laptop or desktop computer, and controlling software is required.

SECTION IV. THEORY OF OPERATION

17.4.1 DTS1 DEWPOINT SENSOR OVERVIEW

This section provides a brief description of how the ASOS DTS1 sensor functions to sense the dewpoint. The DTS1 sensor measures relative humidity (RH) and ambient air temperature to use as a basis for calculating dewpoint. The sensor uses a probe assembly (sensor head) to sense the atmospheric characteristics and a processor to perform the calculations necessary to determine the dewpoint. This description is intended to provide basic familiarity with the purpose and operation of a DTS1 sensor and does not describe the detailed operation of the internal electronics of the sensor.

17.4.2 OPERATIONAL THEORY

The DTS1 utilities a HUMICAP® capacitive thin film polymer sensing technology. The polymer is a hygroscopic product that changes capacitance as water molecules bond to its surface and is protected behind a very thin fine meshed stainless steel filter. When the polymer becomes too saturated with water molecules, capacitance measurements become increasingly difficult. Therefore, the DTS1 incorporates a heating element to dry out the polymer and keep it at a saturation level where capacitance is more accurately measured.

The DTS1 measures the capacity, resistance, and temperature of the polymer. Through a series of equations, the DTS1 calculates the dewpoint temperature.

See Figure 17.4.2-1 for a complete illustration of the DTS1 wiring layout.

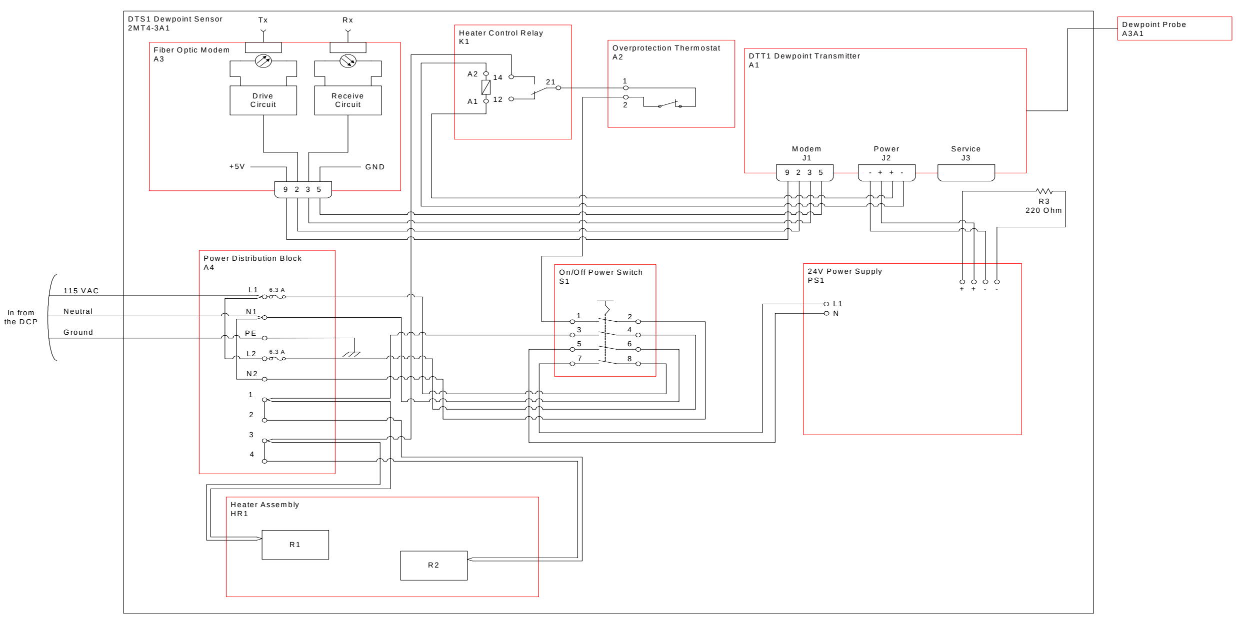

Figure 17.4.2-1 DTS1 Wiring Layout

17.4.3 SENSOR THEORY OF OPERATION

17.4.3.1 Transmitter Electronics

The DTT1 transmitter has two serial ports (9 pin D connectors) and one connector for the transmitter power supply (24 VDC) and for the relay control (4 pin screw connector).

The transmitter supplies 5 VDC for the fiber optic module via the RS232 connector. The transmitter also controls a relay which turns on the enclosure heating when needed. The electronics are located on two component boards: probe assembly and interface module.

17.4.3.2 Probe Assembly

The probe assembly contains the sample space temperature (for conversion of RH to dewpoint) and RH measuring electronics, voltage regulators to produce supply voltages, A/D converter, and a microprocessor to control the operation and perform the calculations. It also has an RS232 circuit for the connection to the fiber optic module and an EEPROM to store all the calibration coefficients and settings. Software is stored in the microprocessor's programmable flash memory.

The transmitter's electronics heat the probe when capacitance reaches 93 percent RH to avoid saturation. A watchdog timer gives a RESET to the transmitter in case of microprocessor malfunction. The transmitter's internal temperature is measured to calculate the electronics temperature compensation and to generate an error message if the temperature is out of range. The internal temperature measurement is also used to control the enclosure heating. Electronics monitor the internal supply voltages for proper operation.

The dewpoint measurement is based on the sensors and on the references. The RH is measured using a Humicap and temperature is measured using a PT100 temperature sensor. When the capacitance of the Humicap is measured there is one reference capacitor at both ends of the measurement range. This gives excellent accuracy and stability. The amplifier or A/D converter can even drift (offset or gain drift) with no effect to the measurement accuracy because it is based on reference values.

17.4.3.3 Interface Module

The interface module contains a 24 VDC/5 VDC converter to produce 5 VDC ± 0.15 VDC for the fiber optic module. It also has an RS232 port for test and service functions.

There is also a control logic to turn the heating relay on. The control causes the microprocessor to give a pulse to the control logic every five seconds to keep the relay on. If the transmitter has failed or the software is malfunctioning, the transmitter can't give these pulses and the relay will turn off to protect against potential overheating.

A reprogramming connector (modular connector) is located on the interface module board under the cover.

17.4.3.4 Measurement and Calculation Algorithms

17.4.3.4.1 Relative Humidity Algorithm

The probe electronics measures capacitance and calculates RH with the sensor model:

$$RH = \sum_{i=0}^{5} \sum_{j=0}^{5} A_{ij}(C)^i T^j$$

where:

RH = relative humidity
C = capacitance
T = temperature
Linearization and temperature compensation of the sensor over the temperature and RH range is done with the coefficient a00...a55 presented in Table 17.4.3.4.1-1.

Table 17.4.3.4.1-1 Default Sensor Variables

$a_{00} = 0.00000000\times10^{00}$	$a_{10} = 5.41486875\times10^{01}$	$a_{20} = 1.30087468\times10^{02}$
$a_{01} = 4.67908586\times10^{00}$	$a_{11} = -2.30457030\times10^{01}$	$a_{21} = 2.18454849\times10^{01}$
$a_{02} = 6.79021033\times10^{00}$	$a_{12} = 5.34721941\times10^{02}$	$a_{22} = -5.973388031\times10^{02}$
$a_{03} = -4.21615182\times10^{01}$	$a_{13} = -4.92525615\times10^{02}$	$a_{23} = 7.54362737\times10^{02}$
$a_{04} = 5.41666480\times10^{01}$	$a_{14} = -8.8828894\times10^{02}$	$a_{24} = 2.27654136\times10^{02}$
$a_{05} = -1.05197128\times10^{01}$	$a_{15} = 1.01239996\times10^{03}$	$a_{25} = 0.00000000\times10^{00}$
$a_{30} = -1.66937857\times10^{02}$	$a_{40} = 1.35690196\times10^{02}$	$a_{50} = -4.81290398\times10^{01}$
$a_{31} = 1.71418925\times10^{02}$	$a_{41} = -5.13650441\times10^{02}$	$a_{51} = 3.94106815\times10^{02}$
$a_{32} = 5.60737572\times10^{02}$	$a_{42} = -4.47927986\times10^{02}$	$a_{52} = 0.00000000\times10^{00}$
$a_{33} = -4.49506984\times10^{02}$	$a_{43} = 0.00000000\times10^{00}$	$a_{53} = 0.00000000\times10^{00}$
$a_{34} = 0.00000000\times10^{00}$	$a_{44} = 0.00000000\times10^{00}$	$a_{54} = 0.00000000\times10^{00}$
$a_{35} = 0.00000000\times10^{00}$	$a_{45} = 0.00000000\times10^{00}$	$a_{55} = 0.00000000\times10^{00}$

17.4.3.4.2 Temperature Algorithm

The resistance of the PT100 is measured and the temperature is calculated

$$T = \sum_{i=0}^{4} D_i R^i$$

Constants:

$$D_0 = -2.43567301\times10^{02}$$
$$D_1 = 2.278542701$$
$$D_2 = 2.050681\times10^{-03}$$
$$D_3 = -6.15025\times10^{-06}$$

$D_4 = 1.34949 \times 10^{-08}$

R = PT100 sensor resistance

17.4.3.4.3 Water Vapor Saturation Pressure Algorithm

The water saturation pressure must be calculated to determine the dewpoint. The calculation is:

$$\Theta = T - \sum_{i-0}^{3} C_i T^i$$

Result:

Θ = virtual temperature

Variables:

T = temperature (K)

Constants:

$C_0 = 4.9313580 \times 10^{-01}$

$C_1 = -4.6094296 \times 10^{-03}$

$C_2 = 1.3746454 \times 10^{-05}$

$C_3 = -1.2743214 \times 10^{-08}$

$$ln P_{ws} = \sum_{b=-1}^{3} b_i \Theta + b_4 ln \Theta$$

Result:

P_{ws} = water vapor saturation pressure (hPa)

Variables:

Θ = virtual temperature

Constants:

$b_{-1} = -5.8002206 \times 10^{03}$

$b_0 = 1.3914993 \times 10^{00}$

$b_1 = -4.8640239 \times 10^{-02}$

$b_2 = 4.1764768 \times 10^{-05}$

$b_3 = -1.4452093 \times 10^{-08}$

$b_4 = 6.5459673 \times 10^{-00}$

17.4.3.4.4 Dewpoint Algorithm

After calculating the water saturation pressure, the dewpoint can be calculated by:

$$T_d = \frac{T_n}{\left(\frac{m}{log(RH/100 \times P_{ws}/a)} - 1\right)}$$

Where:

Table 17.4.3.4.4-1 Dewpoint Algorithm Matrix

T/C	a	m	Tn
. . . 0	6.119866	7.926104	250.4138
0 . . . 50	6.1078	7.5000	237.30
0 . . . 100	5.9987	7.3313	229.10

Finally convert dewpoint from Celsius to Fahrenheit by the following calculation:

$$T_d(°F) = T_d(°C) \times \frac{9}{5} + 32$$

17.4.3.5 Heating Principle Algorithm

The heating algorithm tries to apply enough power to the probe head to keep the measured RH below the following control limits:

For T above 0°C (32°F) Control limit = 80% RH

For T below 0°C (32°F) Control limit = $0.8 \times (0.00335 \times T^2 + 0.945 \times T + 100)$

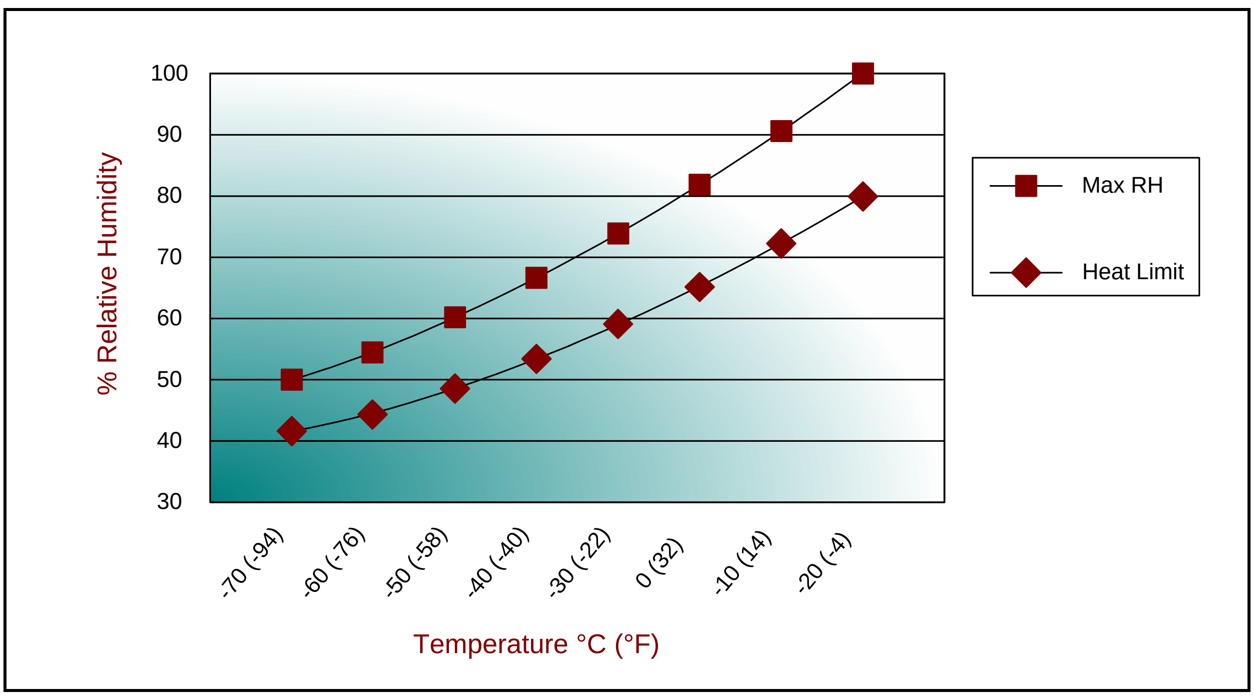

Figure 17.4.3.5-1 Heat Control Limit for T<0 Degrees Celsius

SECTION V. MAINTENANCE

17.5.1 INTRODUCTION

This section contains the preventive and corrective maintenance procedures for the dewpoint temperature sensor. Preventive maintenance consists of tasks and a test to ensure continued operation. Corrective maintenance is assisted by diagnostics and consists of actions and procedures to solve specific problems.

17.5.2 PREVENTIVE MAINTENANCE

Every 90 days the solar shield and filter must be checked and cleaned and dewpoint/temperature readings verified. The dewpoint temperature transmitter requires periodic calibration.

CAUTION

When the DTS1 dewpoint sensor is not powered, e.g., for transport or storage, the probe must be covered and desiccant placed in the electronics enclosure.

17.5.2.1 Inspect and Clean Solar Shield

Visually inspect the solar shield every 90 days or whenever other maintenance is required at the site. Continuous exposure to the elements may foul the internal surfaces of the solar shield with dust, leaves, etc. Although the sensor tolerates a shallow layer of these contaminates, substantial buildup of contaminants can have an effect on the sensor. To prevent problems, clean the solar shield using the following procedure.

CAUTION

The DTT1 transmitter's probe is delicate and must be handled with care. Excessive mechanical shocks can cause permanent damage to the transmitter assembly.

1. At OID, sign on as a maintenance technician and display sensor status page (sequentially press REVUE-SENSOR-STAT function keys from 1-minute display).
2. On sensor status page, set report processing for dewpoint temperature sensor to OFF.
3. Open the enclosure door and remove AC power by setting power switch to OFF (down position).
4. Clean the inside of the solar shield by wiping with clean rag and isopropyl alcohol or by blowing clean with compressed air.
5. At the power supply, apply AC power to sensor by setting power switch to ON (up position).
6. Close and secure the enclosure door.
7. At OID, turn report processing back on for the dewpoint temperature sensor and sign off.

17.5.2.2 Inspect and Replace Probe Filter

Inspect the probe filter when the solar shield is inspected and replace dirty or otherwise contaminated filters using the following procedures.

CAUTION

The exposed DTT1 transmitter probe is delicate and removal of the filter must be handled with care. Excessive mechanical shocks can cause permanent damage to the transmitter assembly.

1. On sensor status page, set report processing for dewpoint temperature sensor to OFF.
2. Open the enclosure door and remove AC power by setting power switch to OFF.
3. Using thumb and forefinger, gently turn the threaded filter counter-clockwise until it disengages from the probe; remove the filter while avoiding contact with the probe.
4. Inspect the filter for dirt, dust, or other contamination; replace with a new filter if appropriate.
5. Using thumb and forefinger, and avoiding contact with the probe, insert and gently turn the threaded filter clockwise until snug.
6. At the power supply, apply AC power to sensor by setting the power switch to ON.
7. Close and secure the enclosure door.
8. At OID, turn report processing back on for the dewpoint temperature sensor and sign off.

17.5.2.3 Verify Dewpoint and Temperature Readings

The dewpoint and temperature readings test is performed every 90 days to verify that the DTS1 dewpoint sensor's readings compare reasonably with readings taken by a Psychron Model 566-2 psychrometer. Conduct this test following the procedures in Chapter 6, Temperature/Dewpoint (Model H083/1088) Sensors.

17.5.2.4 Calibration

The DTT1 transmitter is calibrated and adjusted as shipped from the factory. To meet the accuracy specifications, the transmitter has to be calibrated and adjusted at approved 18-month intervals over the temperature and dewpoint range in controlled laboratory conditions. This is performed at the depot. Site action is restricted to removal of the transmitter to be calibrated and replacement with a currently calibrated unit. Procedures for DTT1 transmitter removal and replacement are contained in Paragraph 17.5.4.1.

17.5.3 CORRECTIVE MAINTENANCE

17.5.3.1 General

The ASOS diagnostic program monitors the ambient and dewpoint temperature readings received from the dewpoint sensor. If the ACU (or DCP) does not receive data from the sensor or the sensor readings are outside acceptable limits, the ACU flags the sensor as malfunctioning and marks it off-line. The fault condition is verified by running the dewpoint sensor diagnostic as described in Chapter 1, Section V.

17.5.3.2 Self-Diagnostics

The DTS1 dewpoint sensor is able to perform two classes of tests: Sensor self diagnostics that run continuously, and extended tests that are executed on demand in response to an external (maintenance) command entered from a laptop computer. The self-test software does not interfere with the collection, processing, storage, or reporting of data.

17.5.3.2.1 Sensor Self-Test

This test is executed continuously without affecting normal sensor operation. It detects, fault isolates, and reports hardware errors affecting sensor operation; isolates anomalies to the most probable failed FRUs.

17.5.3.2.2 Transmitter Self-Test

After power on or reset, the DTT1 tests the function of the EEPROM and the EEPROM's checksum. Tests run continuously checking for a possible short or open circuit in the sensors (humidity and temperature). In addition to sensors, measurement is based on a current generator, voltage reference, humidity measurement circuit, reference resistors, reference capacitors, amplifier, multiplexers, and A/D converter. The test can detect if any of them has failed and can also detect if the output is abnormal or if the probe heating is not functioning.

17.5.3.2.3 Heater, Thermostat, and Power Supply Self-Test

This test measures the internal temperature of the electronics enclosure to check that the heaters are operating and maintaining a minimum enclosure temperature. The heating is turned on/off every 20 hours to verify that the enclosure heating is functioning and shows failure status if the enclosure temperature drops below -40° F.

17.5.3.2.4 Extended Diagnostics

The extended diagnostics are executed in response to the following external serial commands executed at the J3 Service Port (see Paragraphs 17.3.5 and 17.3.6):

1. TEST: Gives the measured raw data.
2. TESTEH: Forces the heating relay to on/off state to verify the enclosure heating function.
3. R (with parameters): Analyzes the function of the DTS1.
4. ERRS: Prints out the extended diagnostics report. See Paragraph 17.5.3.2.5 for message interpretation and indicated corrective action.

17.5.3.2.5 Error Messages

The elements in the following error messages chart are continuously monitored for faults during normal operating conditions, i.e., during normal measurement and/or heating.

Table 17.5.3.2.5-1 Sensor Error Messages

Error Message	Interpretation and Action
EEPROM checksum mismatch	Internal transmitter failure. Replace DTT1 transmitter.
EEPROM read/write	
ADC malfunction	
Analog voltage out of range	
Amplifier chain malfunction	
Enclosure heater malfunction	Check heater element wiring; test heater elements (TESTEH command) Replace DTT1 transmitter or heater elements and manually retest heater elements
Enclosure temperature out of range	Indicated internal temperature is out of allowed -40 to 176°F. Measure temperature; if measured temperature is in valid range replace DTT1 transmitter

Table 17.5.3.2.5-1 Sensor Error Messages (Continued)

Error Message	Interpretation and Action
Operating voltage out of range	Measure voltage; if voltage is in range replace DTT1 transmitter. If operating voltage to the DTT1 transmitter is outside of 12 to 30V range: 1. Check wiring and repeat voltage measurement 2. Replace power supply and repeat voltage measurement 3. Replace DTT1 transmitter and repeat voltage measurement
Fiber optic module supply voltage out of range	Measure voltage; if in range replace DTT1 transmitter If operating voltage to the fiber optic module is outside of the 4.5 to 5.5V range: 1. Check wiring and repeat voltage measurement 2. Replace fiber optic module and repeat voltage measurement 3. Replace DTT1 transmitter and repeat voltage measurement
Temperature sensor open circuit	Check the integrity of the humidity probe and the probe cable. Clean the probe. In case of continuous error, replace the DTT1 transmitter
Temperature sensor short circuit	
Temperature sensor current leak	
Temperature sensor malfunction	
Humidity sensor open circuit	
Humidity sensor short circuit	
Humidity sensor measurement malfunction	
Capacitance value out of range	

17.5.3.3 Troubleshooting

The troubleshooting procedures provided below assist in isolating a fault to an FRU in the DTS1 sensor.

Sensor failure. The DTS1 will display the Command DD, sensor status F when reporting a sensor failure. To troubleshoot total sensor failure:

1. Type ERRS <ENTER> to obtain a more detailed error message
2. Take action as required by the error message.

17.5.3.3.1 Enclosure Heating/Temperature Failure

If the enclosure heating is not functioning it will cause the enclosure heating failure flag to be set to show F state (see command DD). Then, if the enclosure temperature drops below -40° F, also the enclosure temperature failure flag is set to show F state. To troubleshoot enclosure heating/ temperature failure:

NOTE

Check the wiring diagram in Paragraph 17.4.2 as necessary while executing the following steps.

1. Check that AC power (115 VAC) is applied to the terminal block of the DTS1 (L2, N2).
2. Check that the power is applied to power switch (Q1/4, N2). If not, then the fuse (located inside L2 terminal block) is broken and should be replaced.
3. Check that the power is applied to the heaters (measure between terminal block 1 and N2 and terminal block 2 and N2). If not, check that the power switch (Q1) is ON.

4. Connect the laptop PC to the DTT1 service port (J3). Use terminal program with 2400 baud, 1 start bit, 8 data bits, 1 stop bit, no parity.
5. Wait at least 30 seconds after power on, then use the command TESTEH ON to force the enclosure heating control continuously on (see TESTEH command description).
6. Now check that the relay control is really on (24 ± 4 VDC between K1/A2 and K1/A1). If not, check once again that the enclosure heating is really turned on by using the TESTEH ON command.
7. If the software control is on (enclosure heat ON) but there is no voltage (24 VDC) between K1/A2 and K1/A1, then the DTT1 transmitter is broken and should be replaced.
8. If 24 VDC control goes to the relay, check that there is no voltage at the relay (between K1/21 and K1/14). If there is 115 VAC over the relay, then the relay is broken and should be replaced.
9. Check that the thermostat is set to 140 F. Check that there is no voltage at the cutoff thermostat (between T1/1 and T1/2). If there is 115 VAC over the thermostat, replace the thermostat.
10. Force on (turn on in continuous mode) the enclosure heating control, and carefully feel the plate where the heaters are mounted to confirm that the heaters are working.
11. Check the operation of the heaters. To determine if the heater is the cause of the failure:
    a. To check the heaters, switch the power of the DTS1 OFF and disconnect the wires of the heaters from the terminal blocks (1 to 4).
    b. Separately measure the resistance of both heaters. The heater is a power resistor, whose resistance value depends strongly on the resistor temperature as illustrated in Figure 17.5.3.3-1 Heater Resistance vs. Temperature.

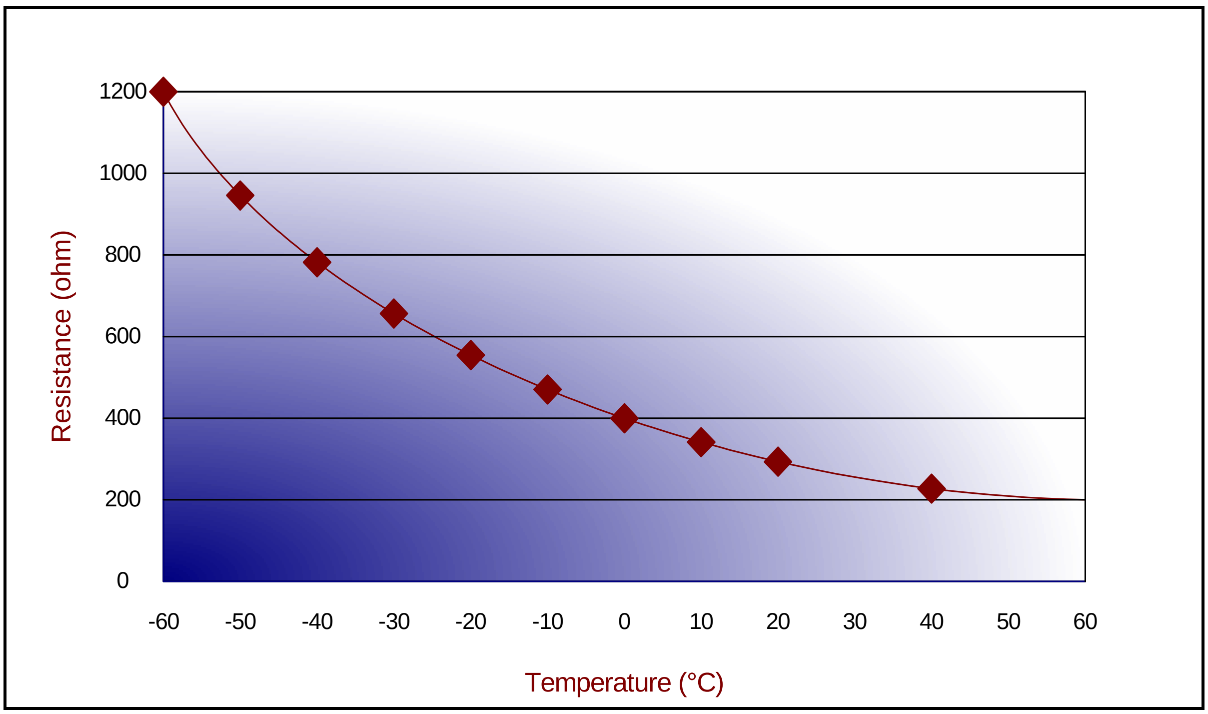

Figure 17.5.3.3-1 Heater Resistance vs. Temperature.

    c. The primary cause of heater failure is either an open circuit or short circuit. If the heater is broken, it should be replaced.
    d. The enclosure heating self test is based on the measurement of the internal temperature of the DTS1. The temperature sensor is located inside of the DTT1 transmitter. The internal

temperature reading can be checked by using R DTT command (see R command description). If it seems like there is something wrong with the temperature measurement (for example, internal temperature reading deviates from the ambient temperature or the reading is not sensible), replace the DTT1 transmitter.

17.5.3.3.2 DTT1 Transmitter Operating Voltage Failure

The DTT1 measures its own operating voltage. If it goes out of the accepted range (12...30 VDC), the DTS1 sets the transmitter operating voltage failure flag to F (see DD command). To troubleshoot when this happens:

1. Check the input of the power supply (G1/L1, G1/N). It should be 115 VAC.
2. Measure the output of the power supply unit (G1/+, G1/-). It should be 24 ± 4 VDC. If not, disconnect J2 connector from the transmitter. If the reading is still out of 24 ± 4 VDC, replace the power supply. If connecting J2 connector drops the output of the power supply out of 24 ± 4 VDC range, then there is probably something wrong with the DTT1 transmitter. Replace the transmitter.
3. If the output of the power supply is within 12...30 VDC but the DTT1 still gives operating voltage out of range message when asked with ERRS <cr> command, replace the DTT1 transmitter.

17.5.3.3.3 DTS1 to ASOS Communication Failure

Troubleshoot if the DTS1 is not responding:

1. Check that the AC power (115VAC) is available at the terminal block of the DTS1 (L1, N1).
2. Check that the power (24 VDC) is at the DTT1 (J2/1, J2/2). If the power is not present, then:
   a. Check the fuse (inside L1 terminal block).
   b. Check that the power switch (Q1) is on.
   c. Check that the input of the power supply is 115 VAC (G1/L1, G1/N).
   d. Check that the power supply outputs 24 VDC. If not, the power supply is broken and should be replaced.
3. Connect the portable PC to the service port (J3). Use terminal program with 2400 baud, 1 start bit, 8 data bits, 1 stop bit, no parity. Try to get a response from the DTT1 by using the R command.
   a. If no response, the DTT1 transmitter needs to be replaced.
   b. If there is a response to the laptop PC but not to the ASOS via the fiber optic module, switch the DTS1 OFF (Q1). Disconnect the cable from the fiber optic module port of the DTT1 (J1). Now, connect the serial line of the portable PC to the fiber optic module port (J1). Turn the DTS1 ON and see if there is a response (2400 baud, 1 start bit, 8 data bits, 1 stop bit, no parity). Use serial line cable where only Rx, Tx, and GND wires are connected (3-wire cable). If no response, then the DTT1 transmitter should be replaced.
4. If there is a response, turn the power OFF and reconnect the cable going from the fiber optic module to the DDT1 transmitter's module port (J1).
5. Turn the power ON and check that the supply voltage of the fiber optic module is 5 ± 0.15 VDC. The supply voltage can be measured from the terminal block of the fiber optic module. If the supply voltage is OK, either the fiber optic module or the connection to the ASOS needs to be replaced.

17.5.4 FRU REPLACEMENT PROCEDURES

WARNING

Death or severe injury may result if power is not removed from sensor prior to maintenance activities. Ensure that circuit breaker (located in DCP) supplying power to sensor is set to OFF.

A list of DTS-1 FRUs is described in Table 17.5.4-1

Table 17.5.4-1 DTS1 Field Replaceable Units

Item Name	ASN
Dewpoint Temperature Sensor	S100-2MT4-3
Probe/Transmitter Assembly	S100-2MT4-3A1A1
Thermostat, OTP	S100-2MT4-3A1A2
Modem, Fiber Optic Module	S100-2MT4-3A1A3 or S100-2A3A1-1
Fuse, 2A (5 X 20mm)	S100-2MT4-3A1F1
Probe Filter	S100-2MT4-3A1FL1
Heater, Enclosure	S100-2MT4-3A1HR1
Relay, Heater	S100-2MT4-3A1K1
Power Supply	S100-2MT4-3A1PS1
Resistor, High Power Load	S100-2MT4-3A1R1
Probe Retaining (Black) Nut	S100-2MT4-3A2MP4

17.5.4.1 DTT1 Transmitter/Probe (2MT4-3A1A1A1) Removal and Replacement Procedures

The Dewpoint Temperature Transmitter/Probe assembly (DTT1) FRU consists of the probe head, cable, and transmitter electronics box. All of these parts must be removed and replaced as a single unit.

17.5.4.1.1 Transmitter Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Loosen the screw of the flap door on the crossbar end and turn door aside.
4. Rotate the probe fixing springs away from the probe head's groove.
5. Pull the extra cable out of the trap door from the crossbar. Carefully bring the probe up and out of the flap door removing it from the retaining (black) nut (2MT4-3A2MP8-1).
6. Place the yellow plastic probe head cover over the probe.
7. Carefully pull the probe and cable back through the crossbar and through the longitudinal hole of the cross bar. Cut the wire tie holding the cable to the radiation shield.
8. Remove the probe cable bushing nut and rubber seal from the electronics enclosure bottom.
9. Remove the split rubber seal from the cable. Remove the bushing nut from the cable by sliding it over the probe head.
10. Inside the electronics assembly, remove the ribbon cable connector from the MODEM jack, J1, on the transmitter unit.
11. Remove the power connector from the POWER jack, J2, on the transmitter unit.

12. Carefully pull out on the bottom of the Transmitter unit and then lift up to remove the transmitter unit from the rail.
13. Remove the transmitter assembly from the sensor and coil the cable for shipping.

17.5.4.1.2 Transmitter Installation

1. DO NOT remove the yellow plastic probe head cover from the probe head until the probe head has been feed through the crossbar and out the flap door.
2. Thread the probe through the cable bushing feed through on the enclosure bottom.
3. Attach the transmitter unit to the rail by setting the upper hook of the transmitter back on the top of the rail. Then press the lower side of the transmitter unit so that the clamps snap onto the lower part of the rail.
4. Connect the power connector to the transmitter connector POWER J2.
5. Connect the ribbon cable connector to the transmitter connector MODEM J1.
6. Feed the cable through the split cable bushing and the probe and cable through the cable bushing nut. Attach the split cable bushing and cable bushing nut to the cable bushing feed through on the enclosure bottom. DO NOT tighten the nut at this time.
7. Insert the probe into the longitudinal hole of the crossbar and push the probe through the crossbar until it comes out of the flap door. Tie the cable to the radiation shield using a wire tie fed through the holes of the radiation shield.
8. Pull the probe and the whole cable length out from the flap door.
9. Take OFF the yellow plastic probe head cover. The yellow plastic probe cover should be stored inside the DTS1 when not installed.
10. Thread the probe through the retaining (black) nut setting the probe head's groove at the same level as the fixing springs.
11. Attach the probe to the retaining (Black) Nut by pushing the springs around the groove in the probe head.
12. Close the flap door on the end of the crossbar and tighten the flap door screw.
13. Tighten the cable bushing nut and close the sensor door.
14. Turn the DCP circuit breaker for this sensor ON.
15. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
16. Turn Report Processing for this sensor ON.

17.5.4.2 Overtemperature Protection Thermostat (2MT4-3A1A1A2) Removal and Replacement Procedures

17.5.4.2.1 Thermostat Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Inside the electronics assembly, remove the two wires from the thermostat by loosening the screws on the bottom of the assembly and pulling out the wires. Verify that the wire labels match the labels on the thermostat.
4. Push down on the top of the thermostat and at the same time pull out on the bottom of the thermostat assembly. The thermostat should now easily snap off the rail at this point and may be removed from the sensor cabinet.

17.5.4.2.2 Thermostat Installation

1. Attach the new thermostat to the rail by setting the upper hook of the back of the thermostat on the top of the rail. Then press in on the lower side of the thermostat unit so the clamp snaps onto the lower part of the rail.
2. Connect the two wires to the thermostat by sliding the wires into the proper slots and tightening the screws to secure the wires.
3. Close the sensor door.
4. Turn the DCP circuit breaker for this sensor ON.
5. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
6. Turn Report Processing for this sensor ON.

17.5.4.3 Fiber Optic Module (or modem)(2MT4-A1A1A3) Removal and Replacement Procedures

17.5.4.3.1 Fiber Optic Module Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Snap the fiber optic module mounting bracket from the DIN rail and pull forward slightly.
4. Remove the ribbon cable connector from the fiber optic module DB9 connector.
5. Remove the fiber optic cables from the connectors on the bottom of the fiber optic module. Note the positions of the RX and TX fiber optic cable ends.
6. Remove the mounting screws for the fiber optic module.
7. Remove the fiber optic module from the mounting bracket and prepare for shipping.

17.5.4.3.2 Fiber Optic Module Replacement

1. Place the fiber optic module on the mounting bracket.
2. Replace the mounting screws for the fiber optic module.
3. Connect the fiber optic cables onto the connectors on the bottom of the fiber optic module.
4. Replace the ribbon cable connector onto the fiber optic module DB9 connector.
5. Snap the mounting bracket back onto the DIN rail.
6. Close the sensor door.
7. Turn the DCP circuit breaker for this sensor ON.
8. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
9. Turn Report Processing for this sensor ON.

17.5.4.4 Fuse (2MT4-3A1F1) Removal and Installation Procedures

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Pull down on the lever handle on the end opposite the L1 or L2 label to expose the sensor fuse.
4. Remove the fuse from the plastic carrier and replace with a good fuse of the correct value. The fuse L1 should be 2.0 amp at 250 volt 5X20 fuse and fuse L2 should be 2.0 amp at 250 volt 5X20 fuse.
5. Close the sensor door.
6. Turn the DCP circuit breaker for this sensor ON.
7. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.

8. Turn Report Processing for this sensor ON.

17.5.4.5 Probe Filter (2MT4-3A1FL1) Removal and Replacement Procedures

Remove and replace the probe filter following the procedure in Paragraph 17.5.2.2

17.5.4.6 Enclosure Heater (2MT4-3A1HR1) Removal and Replacement Procedures

17.5.4.6.1 Heater Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Open the sensor cabinet and cover the opening of the power and fiber optic conduit connector with electrical tape to prevent small parts from falling into the conduit.
4. Measure between 1 and 3 of the screw terminals on the lower rail. Should measure approximately 175 ohms at room temperature, resistance increases and decreases with temperature.
5. Measure between 2 and 4 of the screw terminals on the lower rail. Should measure approximately 175 ohms at room temperature, resistance increases and decreases with temperature.
6. Remove the plastic cover over the two heaters and load resistor.
7. Remove the defective heater by removing the two screws holding it in place.
8. Remove the appropriate two wires 1 and 3 or 2 and 4 from the screw terminals on the lower rail and discard the defective heater.

17.5.4.6.2 Heater Installation

1. Measure between the two wires of the new heater. Should measure approximately 175 ohms at room temperature, resistance increases and decreases with temperature.
2. Mount the new heater using the two screws removed earlier to hold it in place.
3. Connect the two wires of the heater to either 1 and 3 or 2 and 4 of the screw terminals on the lower rail.
4. Replace the plastic cover over the two heaters and load resistor.
5. Remove the electrical tape from the conduit connector.
6. Close the sensor door.
7. Turn the DCP circuit breaker for this sensor ON.
8. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
9. Turn Report Processing for this sensor ON.
10. Heating Relay (2MT4-3A1K1) Removal and Replacement Procedures

17.5.4.6.3 Heating Control Relay Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Inside the sensor cabinet, lift UP on the relay eject/locking lever. The relay should easily slide out of the relay holder/jack mounted to the rail.

NOTE

If the relay holder/jack requires replacement, it may be removed from the rail assembly by pushing down on the top of the relay holder and then pulling out on the bottom. The relay holder will then be free to be removed from the sensor after disconnecting the associated wires. Replace with the same type of relay holder.

17.5.4.6.4 Heating Control Relay Installation

1. Insert the new relay (coil end down) into the relay holder/jack being careful with connector alignment. Terminals on the relay may be easily bent out of position. See Figure 17.5.4.6.4-1.
2. Pull DOWN on the relay eject/locking lever to lock the relay in place.
3. Close the sensor door.
4. Turn the DCP circuit breaker for this sensor ON.
5. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
6. Turn Report Processing for this sensor ON.

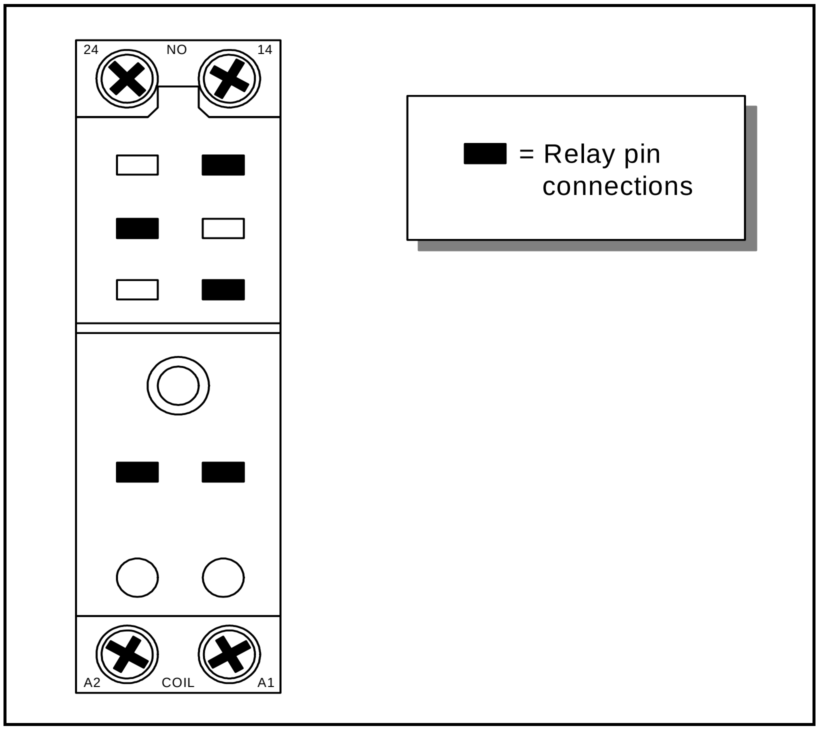

Figure 17.5.4.6.4-1 Heater Control Relay Socket

17.5.4.7 Power Supply (2MT4-3A1PS1) Removal and Replacement Procedures

17.5.4.7.1 Power Supply Module Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Inside the electronics assembly, remove the six wires from the power supply by loosening the screws on the top of the assembly and pulling out the wires. Verify that the wire labels match the labels on the power supply.
4. Pull OUT on the bottom of the power supply assembly and lift UP to remove from the rail and sensor enclosure.
5. Remove the power supply module from the sensor cabinet and prepare for shipping.

17.5.4.7.2 Power Supply Module Installation

1. Attach the power supply module to the rail by setting the upper hook of the power supply back on the top of the rail. Then press the lower side of the Power Supply Module so that the clamps snap onto the lower part of the rail.
2. Connect the six wires to the Power Supply by sliding the wires into the proper slots according to wire label and tightening the screws to secure the wires.
3. Close the sensor door.
4. Turn the DCP circuit breaker for this sensor ON.
5. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
6. Turn Report Processing for this sensor ON.

17.5.4.8 Loading Resistor (2MT4-3A1R1) Removal and Replacement Procedures

17.5.4.8.1 Loading Resistor Removal

1. Turn Report Processing for this sensor OFF.
2. Turn the DCP circuit breaker for this sensor OFF.
3. Open the sensor cabinet and cover the opening of the power and fiber optic conduit connector with electrical tape to prevent small parts from falling into the conduit.
4. Remove the plastic cover over the two heaters and load resistor.
5. Remove the appropriate two wires (+ and -) from the screw terminals on the top right of the power supply module.
6. Measure the resistance of the load resistor. The resistor should measure approximately 220 ohms at room temperature.
7. Remove the defective load resistor by removing the two screws holding it in place and discard the defective resistor.

17.5.4.8.2 Loading Resistor Installation

1. Measure between the two wires of the new Load Resistor. Should measure approximately 220 ohms at room temperature.
2. Mount the new Load Resistor using the two screws removed earlier to hold it in place.
3. Connect the appropriate two wires (+ and -) to the screw terminals on the top right of the power supply module.
4. Replace the plastic cover over the two heaters and load resistor.
5. Close the sensor door.
6. Turn the DCP circuit breaker for this sensor ON.
7. Verify that the sensor is recording accurate readings in the Current and 12 Hour data bases before turning Report Processing ON.
8. Turn Report Processing for this sensor ON.